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JEE

LECTURE - 09

Atomic structure

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Q. What is the longest wavelength of balmar series of Li ions

A 4 R/36

B 8R/9

C 16/9R

D NONE OF THESE ✓

Ans batao ⇒ 50sec

$n_1 = 2$

$n_2 = 2+1 = 3$

$\frac{1}{\lambda} = \frac{5R}{4}$

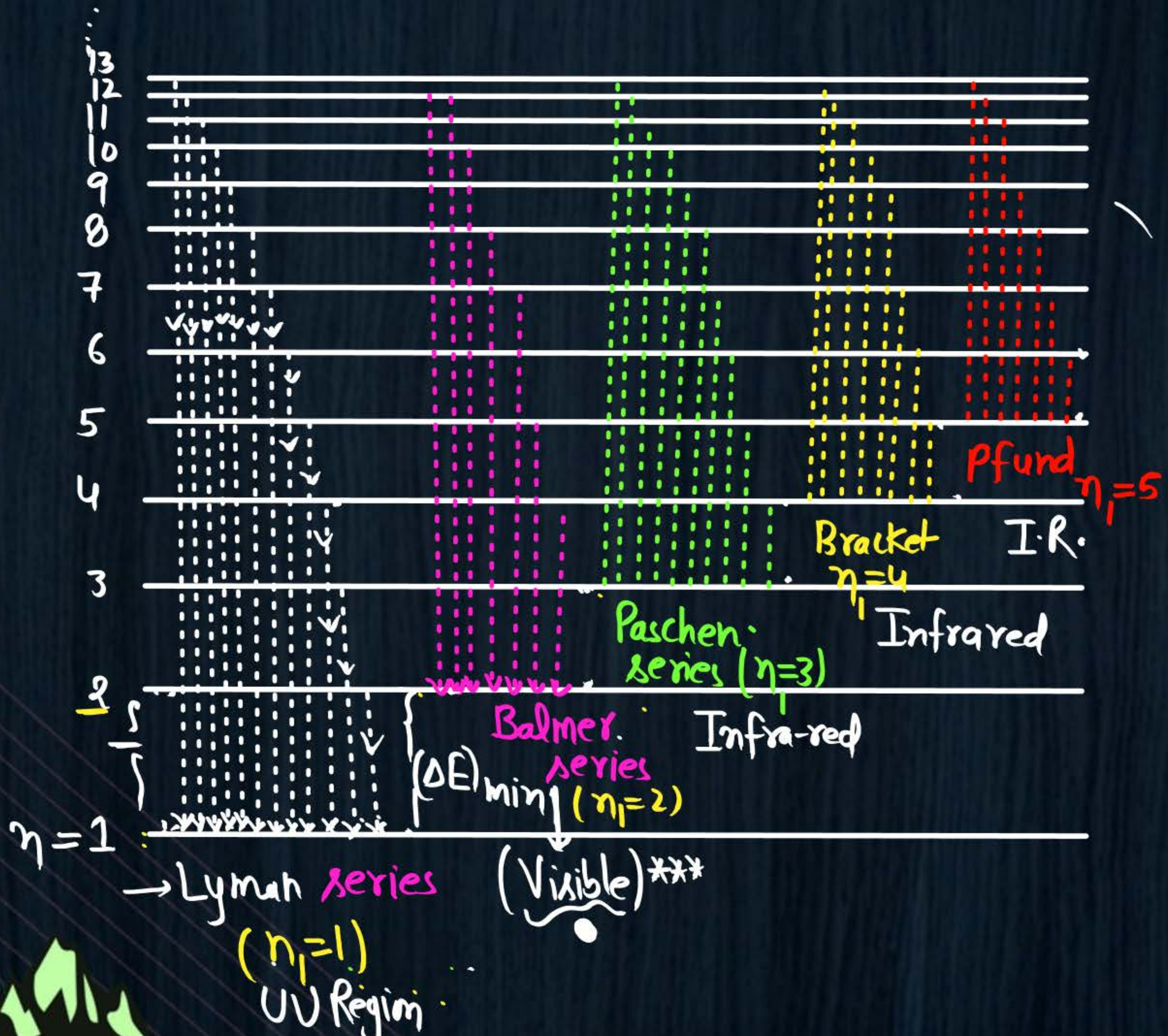
$\boxed{\lambda = \frac{4}{5R}}$

$Z = 3$

$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$= R(3)^2\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = R \times 9\left(\frac{5}{9 \times 4}\right) = \frac{5R}{4}$

HYDROGEN SPECTRUM



$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Where → λ = emitted wavelength

Z = Atomic No.

R → Rydberg Constant

$R = 109677$

n_1 = lower Energy level

n_2 = upper Energy level

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Shortest (λ) | longest (λ)

Lyman $\rightarrow n_1 = 1 \rightarrow \frac{1}{\lambda} = RZ^2\left(\frac{1}{1^2} - \frac{1}{n_2^2}\right) \rightarrow \lambda_{min} \Rightarrow n_2 = \infty$ $\quad \lambda_{max} = n_1 + 1 = 2$

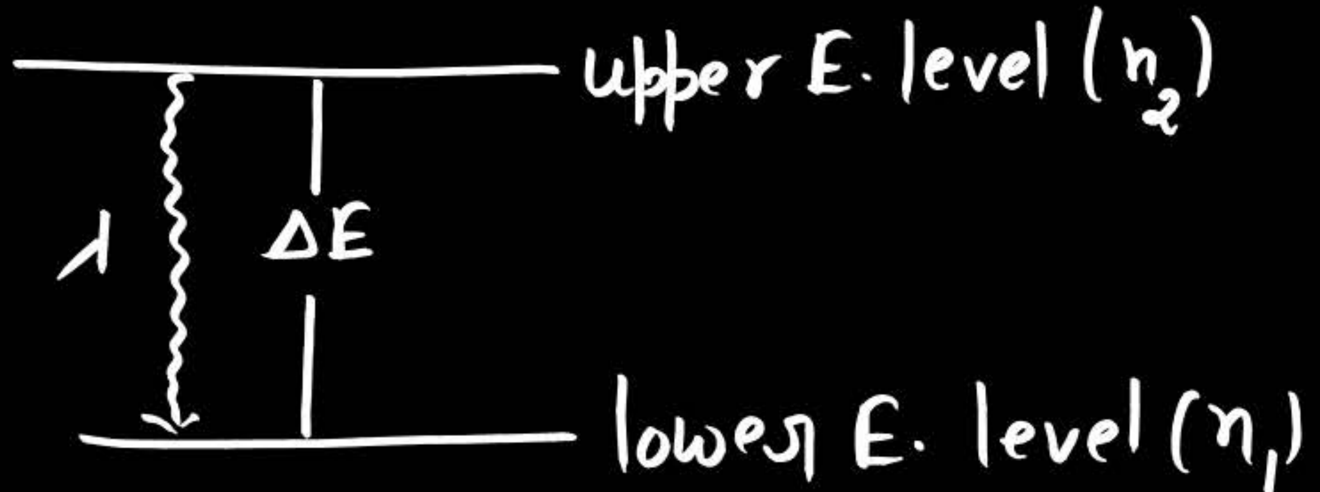
Balmer $\rightarrow n_1 = 2 \rightarrow \frac{1}{\lambda} = RZ^2\left(\frac{1}{2^2} - \frac{1}{n_2^2}\right) \rightarrow \lambda_{min} \Rightarrow n_2 = \infty$ $\quad \lambda_{max} = n_1 + 1 = 3$

Paschen $\rightarrow n_1 = 3 \rightarrow \frac{1}{\lambda} = RZ^2\left(\frac{1}{3^2} - \frac{1}{n_2^2}\right) \rightarrow \lambda_{min} = n_2 = \infty$ $\quad \lambda_{max} = n_1 + 1 = 4$

Bracket $\rightarrow n_1 = 4 \rightarrow \frac{1}{\lambda} = RZ^2\left(\frac{1}{4^2} - \frac{1}{n_2^2}\right) \rightarrow \lambda_{min} = n_2 = \infty$ $\quad \lambda_{max} = n_1 + 1 = 5$

Pfund $\rightarrow n_1 = 5 \rightarrow \frac{1}{\lambda} = RZ^2\left(\frac{1}{5^2} - \frac{1}{n_2^2}\right) \rightarrow \lambda_{min} = n_2 = \infty$ $\quad \lambda_{max} = n_1 + 1 = 6$

$\underline{C_{SD} = 21}$



$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\frac{hc}{\lambda} = hcRZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\Delta E = \underline{hcRZ^2}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

↓ Const

$$\Delta E \propto \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$\underline{C_{SD} = 21}$

****

$$(\Delta E)_{gap} \propto \left|\frac{1}{n_1^2} - \frac{1}{n_2^2}\right|$$

Q **H-atom**

select max energy release in transition

(a) $n = 3$ to $n_1 = 1$ ✓✓

(b) $n = 5$ to $n = 3$

$$\Delta E \propto \left| \frac{1}{n_1^2} - \frac{1}{n_2^2} \right|$$

(a) $\frac{1}{1^2} - \frac{1}{3^2} = 1 - \frac{1}{9} = \frac{8}{9}$

(b) $\frac{1}{3^2} - \frac{1}{5^2} = \frac{1}{9} - \frac{1}{25} = \frac{\cancel{16}^{\,8}}{9 \times \cancel{25}_{\,12.5}} = \frac{8}{9 \times 12.5}$

Q. Which of the following electron transitions in a hydrogen atom will require the largest amount of Energy?

A From n = 1 to n = 2 $1-\frac{1}{4}=\frac{3}{4}$ 0.7

B From n = 2 to n = 4 $=\frac{1}{4}-\frac{1}{16}=\frac{3}{16}$ ✗✗

C From n = 5 to n = 1 ✗ E-release

D From n = 3 to n = 5 $=\frac{1}{9}-\frac{1}{25}=\frac{16}{9\times25}$ 0.0

deni padti hai → lower → upper energy level me jayega

$$\Delta E \propto \left|\frac{1}{n_1^2}-\frac{1}{n_2^2}\right|$$

Q minimum amount of energy release in given transition.

(a) $n = 3$ to $n = 2$

(b) $n = 3$ to $n = 1$

(c) $n = 2$ to $n = 1$

(d) $n = 5$ to $n = 4$ ✓

50 Sec ⇒ Ans batao

$$(\Delta E)_{gap} \propto \left| \frac{1}{n_1^2} - \frac{1}{n_2^2} \right|$$

(a) $\frac{1}{4} - \frac{1}{9} = \frac{5}{4 \times 9}$

xx (b) $\frac{1}{1} - \frac{1}{9} = \frac{8}{9}$

(c) $\frac{1}{1} - \frac{1}{4} = \frac{3}{4}$

(d) $-\frac{1}{16} - \frac{1}{25} = \frac{9}{16 \times 25}$ ✓

$C_{SD} = 22$

(1) No. of spectral line release when e^- jump n^{th} energy level to ground Energy level ($n=1$) $= \frac{n(n-1)}{2}$

(2) If e^- jump $\rightarrow n_2^{th} \rightarrow n_1^{th}$ ($n_1 \neq 1$, $n_1 > 1$)

No. of spectral line $= \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$

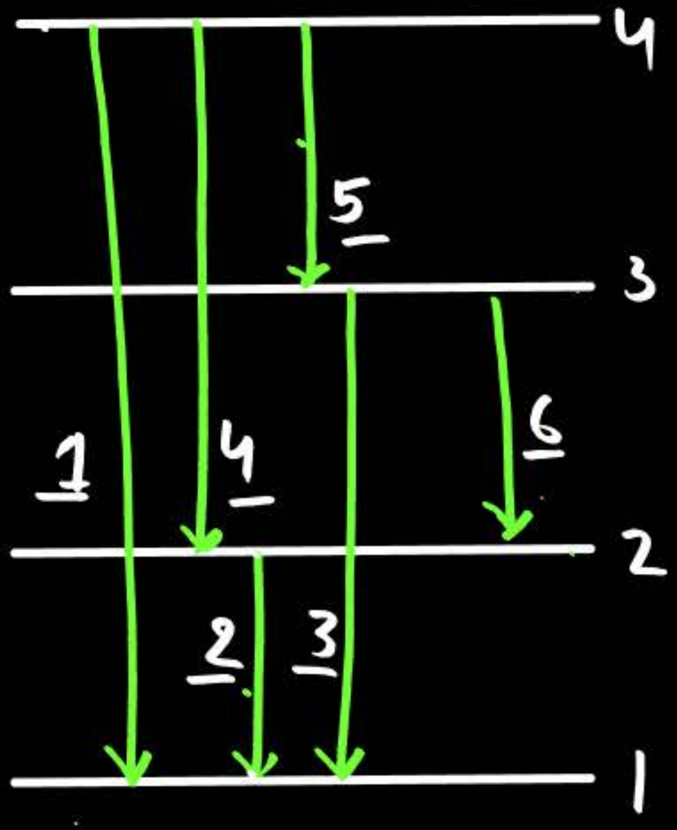
(3) No. of specific series line $= n - n_1$ (n_1 = value of series)

Example → No. of Balmer series line = ?

No. of paschen line series = ?

Q → $\eta = 4$ to $\eta = 1$ → How many wavelength (spectral line) release

(a) 7 (b) 4 (c) 5 (d) 6



No. of spectral line $= \frac{\eta(n-1)}{2}$

$= \frac{4 \times 3}{2} = 6$

Q How many spectrical lines release, when electron jump $n = 4$ to $n = 1$ (ground energy level)

(a) 6 ✓

(b) 12

(c) 4

(d) 8

$$= \frac{n(n-1)}{2}$$

$$= \frac{4 \times 3}{2} = 6$$

Q How many spectrical lines release, when electron jump

$n = 4$ to $n = 2$

(a) 6

(b) 3 ✓

(c) 4

(d) 8

$$= \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$$

$$= \frac{(4-2)(4-2+1)}{2}$$

$$= \frac{2 \times 3}{2} = \textcircled{3}$$

(Balmer)

Q How many visible region line emit, when e^- jump $n=5$ to ground energy level.

(a) 1

(b) 2

(c) 3

(d) 4

$\frac{n(n-1)}{2} \rightarrow$ total line $= \frac{5 \times 4}{2} = (10) \rightarrow (x)$

$\longrightarrow n - n_1 = 5 - 2 = (3)$

Q→ How many Paschen series line emit, when e^- jump $n=5$ to ground E.level.

Sol^n = $5 - n_1 \Rightarrow 5 - 3 = (2)$

$(n_1 = 1)$

Q How many Lyman region line emit, when e^- jump $n=5$ to ground energy level.

(a) 1

(b) 2

(c) 3

(d) 4

$n - n_1 = 5 - 1 = \boxed{4}$

DUAL NATURE OF PARTICLE

→ dual natur light
- → wave → interference, diffraction
- → particle → photon
  - Ex → photoelectric effect
  - → Hydrogen spectrum
  - → Black body radiation

De-broglie's → particle
- → wave
- → particle

DEBROGLIE'S WAVELENGHT

wavelength → $\boxed{\lambda = \frac{h}{mu} = \frac{h}{p}}$

<u>Where</u> → λ = De-broglie's wavelength

h = plank's Const

m = mass of particle

u = Velocity of particle

p = momentum of particle

$(p = mu)$

Q. Calculate de-broglie's wavelength of e^-, which is revolving at speed = 3×10^4 m/sec.

Sol^n → $\lambda = \frac{h}{mu} = \frac{6.6 \times 10^{-34}}{9.1 \times 10^{-31} \times 3 \times 10^{4}} = 2.4 \times 10^{-8}$

$h = 6.6 \times 10^{-34}$ J.Sec

$m = 9.1 \times 10^{-31}$ Kg

$u = 3 \times 10^{4} \frac{m}{sec}$

$\lambda = 2.4 \times 10^{-8}$ m = **240 A°**

$2.4 \times 10^{2} \times 10^{-10}$ m

240 A°

$C_{SD} = 23$

① $\lambda = \frac{h}{p} = \frac{h}{mu} = \frac{h}{\sqrt{2 K.E. \times m}}$

② $\lambda = \frac{h}{\sqrt{2 \times q \times V_0 \times m}} = \frac{h}{\sqrt{2(h\nu - h\nu_0) \times m}}$

$h\nu = \omega + K.E$

$\rightarrow K.E = h\nu - \omega = h\nu - h\nu_0$

$\frac{1}{2} m u^2 = K.E$

$\frac{1}{2} m^2 u^2 = K.E. \times m$

$m^2 u^2 = 2 K.E \times m$

$mu = \sqrt{2 K.E \times m}$

Photo-electronic

$K.E. = q \times V_0 = eV_0$

Where → Stopping potential (V_0)

Q. K.E. of proton and α-particle is 2E, 4E

arrange de-broglies wavelength

(a) $\lambda_p > \lambda_\alpha$

(b) $\lambda_p = \lambda_\alpha$

(c) $\lambda_p < \lambda_\alpha$

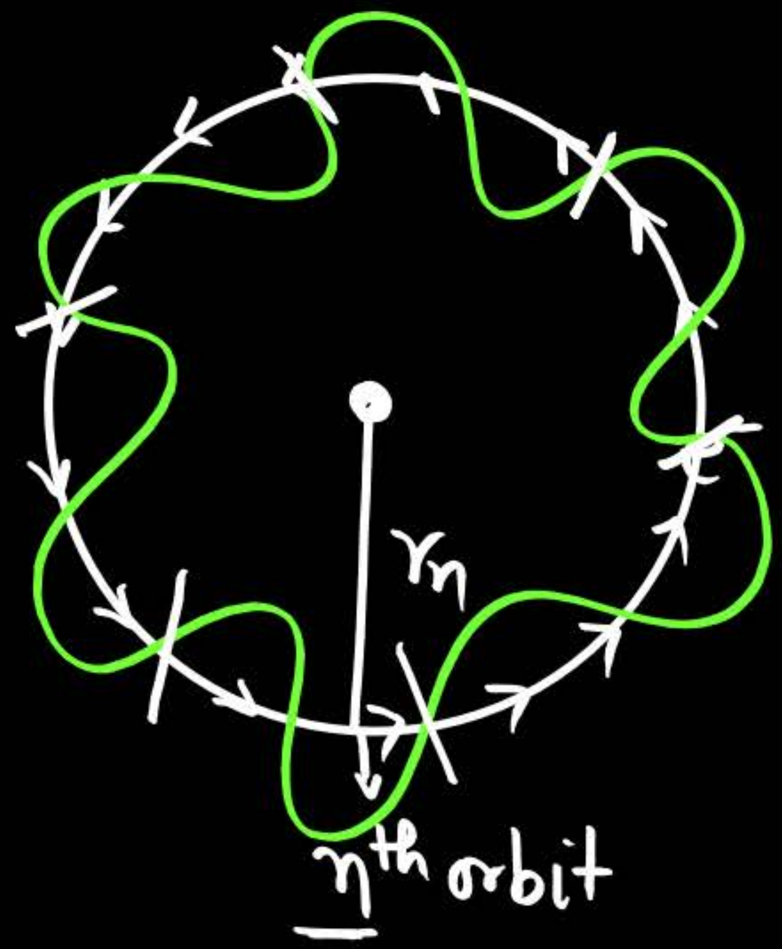
(d) None of correct

Soln

$$\lambda = \frac{h}{\sqrt{2 K.E \times m}}$$

$$\lambda_p = \frac{h}{\sqrt{2 \times 2E \times 1}} \quad ({}_1H^{1})$$

$$\lambda_\alpha = \frac{h}{\sqrt{2 \times 4E \times 4}} \quad ({}_2He^{4})$$



$C_{SD} = 24$

$$2\pi r_n = n \times \lambda$$

λ = de-broglie's wave

Jitna orbit Ka number hota hai

Utni wavelength Kharch hoti hai

1 cycle me

n = No. of orbit

r_n = radius of revolving orbital

Q → How many de-broglie's wavelength required of e^- revolving 3rd orbit

(a) 2

(b) 1

(c) 3 ✓

(d) 4

Q If radius of 2nd orbit is x A°, than calculate de-broglie's wave of revolving e^-

(a) $2\pi x$

(b) πx ✓

(c) $4\pi x$

(d) None of these

Sol^n → $2\pi r_n = n\lambda$

$2\pi r_2 = 2 \times \lambda$

$\lambda = \pi r_2$

$= \pi x$

Q If radius of 1st orbit is x A^0, than calculate de-broglie's wave length 4th orbit.

(a) $\frac{\pi x}{2}$

(b) $2\pi x$

(c) $16\pi x$

(d) None of these

$r_n = 0.529 \times \frac{n^2}{Z} A^0$

$\frac{r_{n_1}}{r_{n_2}} = \frac{n_1^2}{n_2^2}$

$\frac{r_1}{r_4} = \frac{1^2}{4^2}$

$\frac{x}{r_4} = \frac{1}{16}$

$r_4 = 16x$

Sol^n → $2\pi r_n = n \times \lambda$

→ $2\pi r_4 = 4 \times \lambda$

$2\pi \times 16x = 4\lambda$

$\lambda = 8\pi x$

Q. The de Broglie wavelength of an electron in the 4th bohr orbit is:

where → a_0 = 1st bohr orbital

[09 January (Morning) 2020]

A $4\pi a_0$

Ans batao

1 minute

B $2\pi a_0$

C $8\pi a_0$ ✓

D $6\pi a_0$

$$\frac{r_{n_1}}{r_{n_2}} = \frac{n_1^2}{n_2^2}$$

$$\frac{a_0}{r_4} = \frac{1^2}{4^2}$$

$$r_4 = 16a_0$$

$$2\pi r_n = n\lambda$$

$$2\pi r_4 = 4\lambda$$

$$2\pi \times 16a_0 = 4\times\lambda$$

$$\lambda = 8\pi a_0$$

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Home work

DPP. No=6

Thank - You

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